

UNITED STATES MARINE CORPS

LESSON PLAN

SEASONS OF THE EARTH

INTRODUCTION:

1. Gain Attention. The snow- birds (Yankees) go to Florida for the winter because the winters are too cold they want to play on the beach and wear shorts. Then they leave for the summer to get away from the sweltering heat because it is too hot. But in the spring and summer the younger ones go there but that's for a totally different reason. In this class we will learn what causes these temperature differences in geographic location and also learn what causes the changes to happen year after year in the first place.
2. Overview. This period of instruction provides a fundamental understanding of the Earth's relationship to the Sun as it completes its annual migration around the Sun.
3. Introduce Learning Objectives.
  - a. Terminal Learning Objective. Without the aid of reference, explain, with moderate understanding, the seasons and the reasoning behind them.
  - b. Enabling Learning Objective(s). Without the aid of references, but in accordance with the instruction,
    - (1) Explain why the plane of the ecliptic does not coincide with the plane of the Equator.
    - (2) State the relationship between the four (4) major parallels and the solstices.
    - (3) State the significance of the Equinoxes.
4. Method/Media. This period of instruction will be taught using the lecture method with aid of QMMCBT-001 "Introduction to the Dynamics of the Atmosphere".
5. Evaluation. You will be evaluated by demonstrating that you understand the causes of seasons.

TRANSITION. We know that it is colder in the winter than in the summer, but as we have already learned (Rotation and Circular Motion of the Earth - QMMPH1-006), the distance between the Earth and the Sun has no direct affect on the surface temperatures of the Earth. During January, the Earth is actually at its closest point to the Sun, but the Northern hemisphere experiences its winter season.

BODY:

1. The Earth's Orientation. Fluctuations in the Sun's angle and the amount of daylight consistently change throughout the year because the

Earth's orientation to the Sun continually changes as it moves about its elliptical orbit.

a. The imaginary line from the North Pole to the South Pole is the Earth's axis. It is this axis that the Earth spins about and it is not perpendicular to the plane of the Earth's orbit around the sun. This plane is called the *plane of the ecliptic*. Earth's axis actually lies at a  $23.5^\circ$  tilt from the perpendicular. This tilt is known as the inclination of the rotation axis. Earth's axis is always pointed towards Polaris, the North Star, throughout its entire orbit. Stated another way, at any given point during the year, Earth's axis will be parallel to its own axis at any other given point throughout the course of the year. Use Figure XXX and notice that the Earth's axis is always tilted at  $23.5^\circ$  towards the North Star. This is known as parallelism, or polarity of the axis.

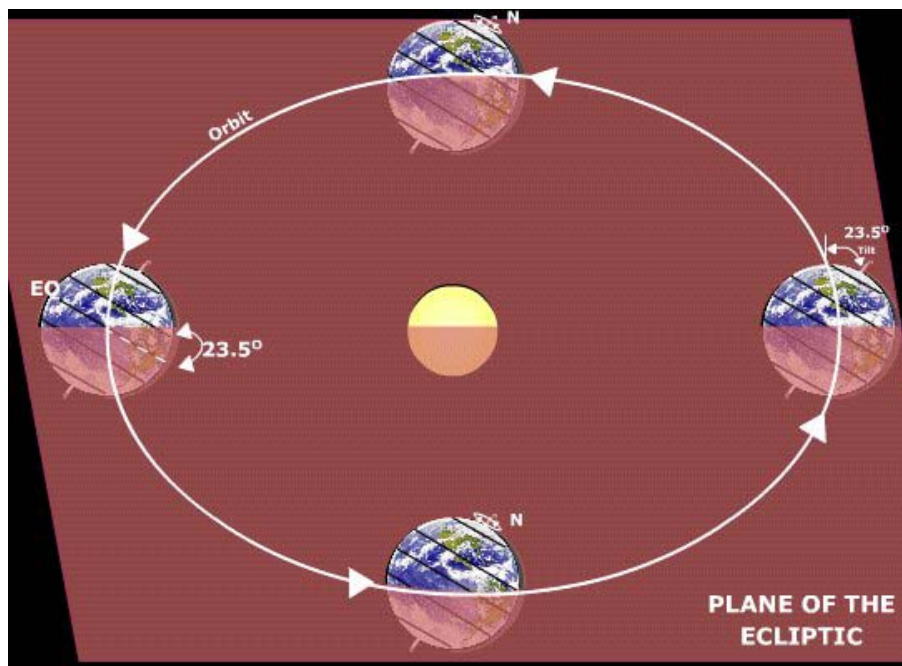


Figure 1 - The Earth's Plane of the Ecliptic.

b. The combined effects of the Earth's rotation, revolution, inclination (tilt), and polarity cause the Sun's angle to change throughout the year. The angle at which the Sun's rays strike the Earth play a critical role in determining the amount of solar energy that is received at any given location on the surface of the Earth.

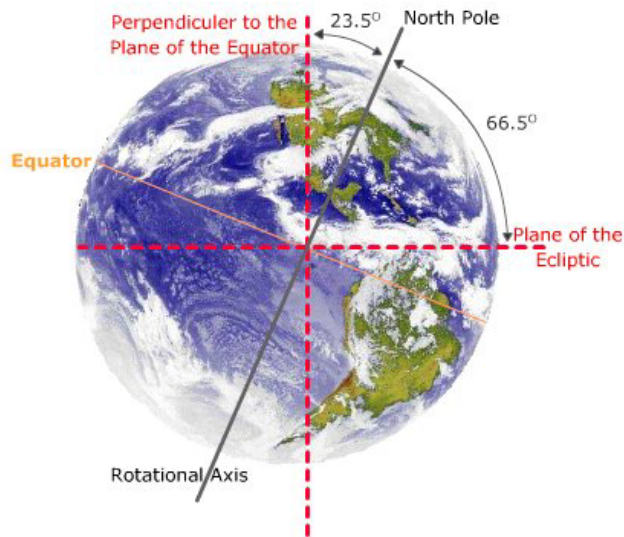


Figure 2 - The Earth's Plane of the Ecliptic and Rotational Axis.

c. If the Earth did not rotate about a tilted axis, there would be no seasons.

TRANSITION. There are four (4) specific days of the year that have special significance as the Earth's makes its annual journey around the Sun.

## 2. The Solstices and Equinoxes.

a. Solstices. There are two (2) specific days of the year when the earth is in a location about its orbit that the Sun's rays are perpendicular to  $23.5^\circ$  North latitude, the Tropic of Cancer, or South latitude, the Tropic of Capricorn. These days are known as the summer and winter solstices and occur on or about June 21st / 22nd and Dec 21st / 22nd respectively. For this period of discussion, we will focus on the Northern hemisphere with reference to Southern hemisphere events.

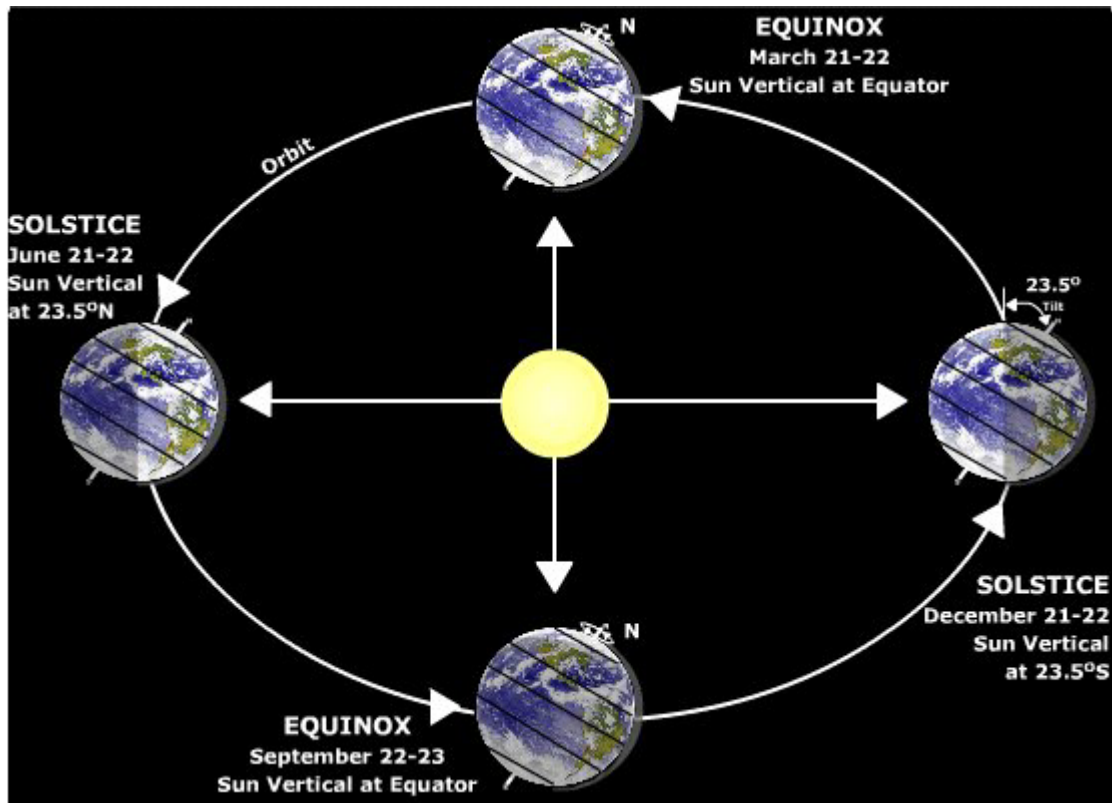


Figure 3 - The Annual March of the Earth Around the Sun.

(1) On or about June 21st or 22nd, the position of the Earth in its orbit is so that it is leaning 23.5° towards the sun. Even though on this day the Earth is actually farthest away from the Sun, it is because of the tilt of the Earth, the Sun's most direct rays are perpendicular to 23.5° North latitude. This provides for more direct sunrays to strike the Northern hemisphere.

(a) June 21st/22nd is also astronomically deemed the Northern hemisphere's "summer solstice". This is the Northern hemisphere's warmest season, the "summer". The summer season is not an exact date but rather a period where the Northern hemisphere experiences the warmest days of the year. Typically, the warmest months are in June, July and August.

(b) In the Southern hemisphere, this day is known as the "winter solstice" and is the Southern hemisphere's winter season.

(2) On or about December 21st or 22nd, the position of the Earth in its orbit is so that it is leaning 23.5° away from the sun. The Sun's most vertical rays are now perpendicular to 23.5° South latitude.

(a) This date marks the onset of the "official" winter season for the Northern hemisphere. The coldest winter

months are typically December, January, and February where the Sun's rays are distributed over a larger portion of the Earth's surface.

(b) In the Southern hemisphere, this date is known as the summer solstice because the rays of the Sun are perpendicular to the Tropic of Capricorn.

b. Equinoxes. The equinoxes occur midway between the solstices and mark the day where every location on Earth receives twelve (12) hours of daylight. September 22nd or 23rd marks the Northern hemisphere's autumnal equinox, and March 22nd or 23rd is the vernal (spring) equinox. The opposite holds true for the Southern hemisphere.

(1) On these two days, the vertical rays of the Sun are perpendicular to the Equator. The Earth is located in such a position where the axis is neither pointed towards or away from the Sun.

(2) The circle of illumination touches both poles, allowing for an equal day and night for every location on Earth.

(3) The equinoxes represent the midpoints in the shift of the direct rays of the Sun between the Tropic of Cancer and the Tropic of Capricorn.

TRANSITION. Understanding Earth's rotation about its axis and the revolution it makes around the Sun, sets the stage for further study of the atmosphere. It is important to understand these basic concepts in the field of meteorology.

OPPORTUNITY FOR QUESTIONS:

1. Questions from the Class. At this time, are there any questions concerning the content you just learned?

2. Questions to the Class.

a. QUESTION. What date does the Northern hemisphere's vernal equinox occur on?

b. ANSWER. On or about March 22nd or 23rd.

SUMMARY: During this period of instruction, the student should have gained an understanding of the Earth's orientation as it completes a revolution around the Sun. The specific dates of the solstices and equinoxes were introduced and their significances were explained. This period of instruction provides fundamental concepts that are needed for any further understanding of meteorology.

REFERENCE:

Lutgens, Frederick K. and Tarbuck, Edward J. The Atmosphere, An Introduction to Meteorology. 9th edition. Pearson Education Inc, 2004.

McKnight, Tom L. and Hess, Darrel. Physical Geography, A landscape Appreciation. 7th Edition. Pearson Education, Inc. 2004.

Ahrens, Donald C. Meteorology Today. 4th Edition. West Publishing Company, 1991.